betweenness, and would be, in fact, identical with one of the sets of independent postulates for betweenness obtained in a forthcoming paper by E. V. Huntington and J. R. Kline. The transition from the theory of cyclic order to the theory of betweenness may thus be made by merely interchanging two letters in the first postulate; postulates II–VI are true in both theories.

A NEW METHOD OF STUDYING IDEATIONAL AND ALLIED FORMS OF BEHAVIOR IN MAN AND OTHER ANIMALS[1]

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Despite widespread interest in the evolution of reasoning, the comparative study of ideational behavior has been neglected. Only a few methods of research have been devised, and these have seen scant service.

Thorndike[2] is responsible for the problem or puzzle-box method (used by him in the study of cats, dogs, and monkeys); Hamilton,[3] for the method of quadruple choices (by which he has studied cats, dogs, horses, monkeys, rats, gophers, and men); Hunter,[4] for the method of delayed reaction (applied by him to rats, raccoons, dogs, and children).

I have perfected and applied a new method—that of multiple choices—for the detection of reactive tendencies and the study of their rôle in the attempted solution of certain types of problem. The method involves the presentation to the subject of a problem or series of problems whose rapid and complete solution depends upon ideational processes.

The apparatus consists of twelve, or, in some forms, nine identical reaction-mechanisms, of which any number may be used for a given experimental observation. In the type of apparatus originally used for human subjects, these mechanisms are simple keys; in that which has been used for lower animals, they are boxes arranged side by side, each with an entrance door at one end and an exit door at the other, which may be raised or lowered at need by the experimenter through the use of a system of weighted cords. Under the exit door of each box is a receptacle in which some form of reward for correct reaction may be concealed until the door of the appropriate box is raised by the experimenter.

It is the task of the subject to select from any group of these boxes whose entrance doors are raised that one in which the reward (food, for example) is to be presented. The experimenter in advance defines the

correct box for any group of boxes which may be used as that which bears a certain definite spatial or numerical relation to the other members of its group. Definitions which have actually been employed (problems presented) are the following: (1) the first box at the left end of the group (as faced by the subject); (2) the second box from the right end of the group; (3) alternately, the box at the left end and the box at the right end of the group; (4) the middle box of the group.

The boxes are presented in varying groups in accordance with a prearranged plan. The subject is punished by confinement in the box selected every time it makes an incorrect choice and is then allowed to choose again, and so on until it finally selects that box which is by definition the correct one. It is then rewarded with food and permitted to pass through the box and return to the starting point, where it awaits opportunity to respond to a new group.

The experimenter keeps a precise record of the subject's choices and of various important aspects of behavior. These data include the nature of the choices from trial to trial, series to series, day to day; the appearance and fate of specific reactive tendencies or methods of attempting to solve a problem; and the final outcome, in success or failure, of prolonged effort.

The essential statistical features of the results obtained with certain types of subject may be summarized briefly thus:

(1) Crows quickly solve problem 1 (first mechanism at one end of the group), with 50 to 100 trials.

Problem 2 (second from the end) they fail to solve in 500 trials. No consistent improvement appears, although there are four conspicuous reactive tendencies: (a) to go to the end box because of previous training in problem 1; (b) to go to the first box at the left and then to the one next in order, which in the particular experiment happened to be the correct one; (this is the most nearly adequate tendency exhibited by the crow); (c) to reënter whichever box happened to be chosen first and to choose next the second box from the left (correct); (d) to enter a box at or near the right end of a group, and on emerging, to turn to the right and enter the box directly in front, and so on until the correct box is located.

In the method of multiple choices, the crow gives no convincing evidence of ideational behavior. Its general intelligence is clearly indicated by alertness, keenness of perception, emotional responsiveness, and rapid adjustment to various essential features of the experimental situation. It appears to be temperamentally ill-suited to the kind of task presented by this method of studying reactive tendencies.

(2) White rats solve problem 1 in from 170 to 350 trials on the basis

of certain acquired motor tendencies, one of which may be described thus. The rat follows the wall of the reaction compartment to the entrance to the box at the right end of the series of boxes. It then turns sharply to the left and passes along close to the boxes until the first open door is reached. This it enters. Kinaesthetic, tactual, and visual data constitute the basis for the motor habits by which rats solve this simple relational problem.

A single individual exhibited reactive tendencies less obviously describable in motor terms, but it is by no means certain that this indicates ideational ability sufficient for the solution of relational problems.

Problem 2 was not solved by rats within 800 trials, and there is no indication in the data that solution is possible to them.

Whereas the influence of training in problem 1 disappeared quickly when problem 2 was presented to the crow, it persisted in the case of the rat for about 100 trials. There are numerous other evidences, in the experimental data, of the higher intelligence of the crow. The rat is distinctly less versatile and markedly less responsive to slight changes in environment.

(3) Pigs solve problem 1 with 50 trials or less; problem 2 with 390 to 600 trials; problem 3 with 420 to 470 trials. Problem 4 is not solved in 800 trials.

These successes as well as the varied reactive tendencies manifested place the pig much higher in the scale of adaptive capacity than the rat or crow.

The data obtained with these three types of subject proves the method of multiple choices to be a feasible means of eliciting reactive tendencies which are characteristic of various points in ontogeny and phylogeny.

Results which have been obtained with monkeys, apes, and men will be presented in separate communications.

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